V. STUDIES ON THE AQUATIC OLIGOCHÆTA OF THE PUNJAB.[1]

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I.—ON *Lahoria*, A NEW GENUS OF THE NAIDIDÆ ALLIED TO *Branchiodrilus*, MCHLSN. (*Chætobranchus*, BOURNE).

The worm of which the following is a description shares with *Branchiodrilus* the remarkable peculiarity of the possession of gill-processes on the anterior part of the body; the hair-setæ of the dorsal bundles are contained within the more anteriorly situated gills; but further back, though still in the region of the gills, a certain number of these setæ project freely.

Branchiodrilus semperi, the only species of the genus originally named *Chætobranchus* by Bourne, was found by him in a tank in Madras town [2]. It has not since then (1890) been recorded from any place in India, nor has it since been encountered at all under what may be described as natural conditions; though Beddard [1] has found specimens in the *Victoria regia* tank at the Botanical Society's Gardens in Regent's Park. The chief difference between this form and the one now to be described, and the feature which makes it necessary to constitute a new genus for the reception of the latter, is the absence of gills and dorsal setæ from the most anterior segments (ii-v) in the present form, and their presence on these segments in the form described by Bourne.

Lahoria hortensis, sp. nov.

The worm was found in a small pond in the Lawrence Gardens, Lahore. This pond is artificial, having been first made about two years ago; it is kept supplied with canal-water by a small irrigation channel, and has been for some time overgrown and almost choked up with aquatic plants. The specimens were first obtained early in July, 1908. The animals lived then in fair numbers on and amongst the water-weeds near the edge of the pond, and it was not difficult to obtain specimens by passing a small net through this vegetation. One or two samples of mud from the bottom of the pond did not seem to contain any of these worms. Specimens were also found later in the year in the same place.

External characters (plate vii, fig. 1).—The worms are usually from about two-thirds of an inch to an inch, or 16—25 mm. in *length*, and less than a millimetre in *diameter*, on an average ·5 to ·75 mm. The *number of segments* varies considerably; specimens which were not preparing to divide showed from 90 to 120

segments; many were, however, preparing for fission, and one of these showed seventy-nine in its anterior and ninety-one segments in its posterior half, or 170 altogether. In addition to the segments recognizable as such, there is always a posterior tapering region of the body where growth is apparently taking place actively, and where distinct segments have not yet been differentiated.

The *prostomium* is bluntly conical in shape, and is well marked, though by no means so large relatively as is figured for *Branchiodrilus* (Bourne, *loc. cit.*, fig. 1). There are no *eyes*. The first few segments, as far as the first gills, form a region of the body which is in preserved specimens somewhat narrower than that which succeeds it, though this is not obvious in the living and moving animal; indeed this region may then appear somewhat swollen. A peculiarity noticed on a number of different occasions was that when after a somewhat prolonged examination a specimen died and began to disintegrate under the microscope, this latter process began by a shrivelling up of the region of the first ten gills, this region of the body becoming wrinkled and much narrower in diameter than before.

The anterior portion of the body is pigmented (plate vii, fig. 2), the *pigment* being black and occurring in granules more or less closely aggregated. On the dorsal surface there is a blotch of pigment about the level of the mouth, just in front of the level of the cerebral ganglion, and there are a few scattered granules towards the tip of the prostomium. A segmental distribution of the pigment is hardly to be recognized in segments ii-iv; but after this it is distributed as well-marked transverse bands one in each segment. These bands become less dense as one proceeds posteriorly, and after about the twentieth segment are inconspicuous; scattered pigment spots occur for some distance further, but these, too, ultimately disappear. On the ventral surface the appearances are more variable; there may be well-defined segmental bands here also, or there may be only scattered spots; but in any case the pigment is less than on the dorsal surface.

The segments are delimited externally by a fairly well-marked *annulation*.

The *branchial processes* are dorso-laterally situated hollow projections of the body-wall, cylindrical in shape, longest in the anterior part of the body, and gradually diminishing posteriorly. The first of these processes are situated on the sixth segment as a rule, but occasionally on the fifth. It is not always easy in the living and moving worm to be certain of the exact numbering of the segments; and I therefore examined a number of individuals fixed and mounted in balsam; in nine such specimens the gills began in segment v in one, in vi in the rest.

The first gill on each side is a little shorter than the second; when turned forwards these reach well in front of the tip of the prostomium. The branchial processes of the anterior part of the body are easily visible to the naked eye, and are over a millimetre in length; the longest I have measured was 1·6 mm. After the

anterior segments they decrease somewhat in size, and become progressively smaller and smaller; about the fortieth segment they may be only ·4 mm. long, about the fiftieth ·3 mm., and after the seventieth they are mere tubercles. These figures are approximate only, and are given for the sake of illustration, as there is a certain amount of individual variation. The processes are however recognizable, though as minute tubercles only, till within quite a short distance of the growth zone at the posterior end of the body; in this respect the present form seems to differ from *Branchiodrilus*, where, according to Bourne's figure, there may be as many as sixty-seven posterior segments without any recognizable processes.

In an animal which was preparing to divide asexually, the anterior portion of seventy-nine segments had recognizable gills throughout its length, the most posterior, just in front of the budding zone, being ·13 mm. long. The first gill of the posterior animal was ·35 mm. long, the second ·48 mm.; as above, small tubercle-like processes were visible to within a short distance of the hinder end, practically as far as distinctly differentiated segments were to be recognized.

These processes in the anterior part of the body contain the dorsal hair-setæ; they are, like the general surface of the body, ciliated; they present here and there short stiff hairs, presumably sensory; they are hollow, and body-cavity corpuscles may be seen moving into or out of them; they contain two well-marked blood-vessels, one afferent and one efferent. They are usually regularly cylindrical in shape, but occasionally show irregularities of outline, and there may be a tendency to forking at the free end (text-fig. 1); they are somewhat constricted at their attachment to the body-wall. They are in the natural condition stiffened by the contained setæ, but appear to possess a certain amount of contractility, since in fixed and preserved specimens the long anterior processes are usually found much curved, often into the shape of a semicircle.

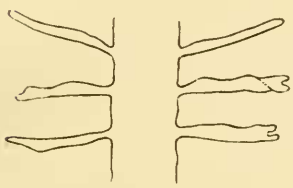

FIG. 1.—Irregularities of shape of branchial processes in *Lahoria hortensis*.

The *setæ*, except in the most anterior region, are in four bundles per segment, two dorsal and two ventral. The *ventral setæ* (text-fig. 2) begin in the second segment; they are of the usual ∫-shape, forked distally, the two prongs being equal in length, the proximal prong, however, being twice as thick at its base as the distal. The nodulus is slightly distal to the middle of the length of the seta, the proportions of the proximal and distal parts of the seta being 7 : 6 or 8 : 7. The total length of these

FIG. 2.—Ventral seta of *Lahoria hortensis*.

setæ varies from ·15 mm. in the anterior to ·13 mm. in the posterior part of the body. I have not been able to recognize any difference in type between the setæ of the anterior and posterior segments. There are usually four or five setæ in each ventral bundle.

The *dorsal setæ* are of two kinds, long slender hair-setæ, and short straight singly-pointed needle-setæ. The hair-setæ are quite smooth; they begin in the same segment as the gills, within which they are at first contained; two such setæ usually extend into each gill, of which one, somewhat longer than the other, may reach very nearly to the tip of the gill; like the gills themselves, their length will thus be, in extreme cases, considerably more than a millimetre.

At a varying distance from the anterior end, about the fortieth to the fiftieth segment, the hair-setæ begin to project freely from the surface of the body; as a rule, however, only one of each bundle does so, rarely two; the gills still contain a seta, a comparatively short one however, in correspondence with the shorter gills. The first free dorsal setæ are longer than the gills they accompany; *e.g.*, the setæ may be ·51 mm. long, the gill ·4 mm.; but the disproportion may be much greater—setæ ·88, gill ·28; or setæ ·5, gill ·144 mm. These hair-setæ, like the gills they accompany, gradually decrease in length posteriorly, though not so markedly as the gills. The needle-setæ, usually two per bundle occur along with the hair-setæ as short pointed rods scarcely projecting beyond the level of the body-wall. I have not seen any sickle-shaped setæ, as described for *Branchiodrilus*.

It has been mentioned that the gills are ciliated; these *cilia* are extremely fine and delicate, and though sometimes visible without much difficulty, are frequently only to be recognized by the movements of small particles in the water in their vicinity. Similarly over the general surface of the animal; the whole body seems to be ciliated, though the cilia themselves are only occasionally to be discerned; their presence is however evidenced by the commotion of minute particles in the water near the surface of the body.

The body-cavity is traversed by well-marked *septa*; these are perforated in places, allowing the lymph-corpuscles to pass from segment to segment. These *corpuscles* are round, and very granular; they are not pigmented.

Alimentary canal.—The mouth cavity is ciliated; the pharynx, an oval dilatation, occupies the first few segments, narrowing about segment vii to become the œsophagus. This is a straight tube continued posteriorly into the intestine; there is no sharp demarcation between these, and it is difficult to say where one ends and the other begins. Antiperistaltic movements are frequent, and may be violent, in the intestine; they may extend as far forwards as the tenth segment. A postero-anterior ciliary action may occur in the intestine of these worms, similar to that observed in *Nais*, *Pristina*, *Slavina*, etc.

Vascular system.—The blood is yellowish red, and contains no corpuscles. The dorsal vessel contracts from behind forwards: it is incorporated with the wall of the intestine, and like the intestine is covered by a layer of chloragogen cells. The ventral vessel is non-contractile, and is separate from the alimentary canal, with which it is connected in each segment by at least two vessels which pass into the wall of the latter. Besides branching vessels to the body-wall there are present in each segment a pair of lateral loops, which in the anterior part of the body extend into the gills (plate vii, fig. 3), the limbs of the loop forming the afferent and efferent vessels of these organs. The afferent vessel, springing from the dorsal vessel, is in this part of the body contractile; further back, where the branchial processes are small, the lateral loops do not extend into them, and no part of the loops is contractile; the lateral loops exist, however, though much reduced in

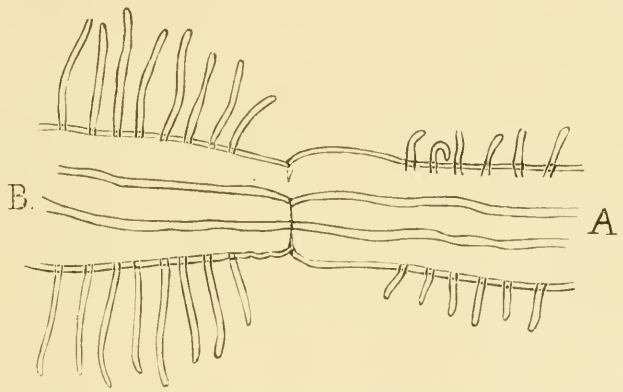

Fig. 3.—Region of approaching division in a specimen of *Lahoria hortensis*; showing portions of both anterior and posterior animals without gill-processes, and hence consisting of newly budded segments: A = anterior animal; B = posterior animal.

size, back to the hinder end of the animal. In the first five segments the lateral vessels do not present the appearance of regular loops, but form an extremely irregular and complicated plexus.

The *nephridia* begin by an open ciliated mouth; parts, at least, of the nephridial tube are also ciliated. I am not certain as to the segment in which they begin, my observations (which were a matter of some little difficulty, since these organs are not in this region very conspicuous) being discordant; in one case the first nephridium seemed to be in segment ix, in another in xi, and again in xiv, xv, xvi and xvii; it is possible that the position varies. They end some little distance in front of the posterior extremity of the animal; thus the last thirteen seta-bearing segments may have none. They become smaller and smaller posteriorly, appearing as small loops in contact with the ventral vessel and attached to the alimentary canal, somewhat as if they were budded out from the latter.

The *nervous system* has the usual relations. The two halves of the cerebral ganglion appear to be more distinct than is often the case in the Naididæ, and in the living condition were seen as two separate ganglia united by a transverse commissure; this is not apparent in preserved specimens.

Asexual reproduction.—In the description of *Branchiodrilus*, Bourne mentions the absence of a budding zone between the two components of a chain, and remarks that the process of division resembles rather a simple fission of the animal into two. The present form, however, shows a distinct, though not extensive, budding zone. A reference to text-fig. 3 will illustrate this. The specimen had almost reached the stage of complete division; and the two components separated, in fact, when the specimen was being transferred to balsam. It will be seen that the last branchial processes of the anterior animal (A) are still of some considerable length, and that the most posterior portion of this animal has no branchial processes at all; this last portion, therefore, is evidently a new production, or the series of branchial processes would have been continued over it. Similarly the anterior portion of the hinder animal (B); the ventral setæ (not shown in figure) are small—hence new productions, not a continuation of the original series; and, as usual, these anterior segments are without gill-processes, which would have been present, and even of moderate size, had these segments been a continuation of those of the anterior animal.

It appears, therefore, that the posterior segments of the anterior of two still conjoined animals are produced in a budding zone, and that the same is the case with the anterior five segments of the posterior component. It is interesting to compare this phenomenon with what occurs in *Chætogaster* [10] and *Nais* [11]; in both these forms the anterior region, comprising five segments which are differentiated from the rest by the distribution of the setæ, is formed as a new production in the budding zone; in the present form also these segments are differentiated from the rest (by the absence of dorsal setæ), and are formed in the budding zone; while in *Branchiodrilus*, where there is no differentiation, the budding zone is inconspicuous, being limited presumably, as far as the posterior animal is concerned, to the production of the prostomium and first segment. *Genital organs* have not been observed.

Systematic position.—The presence of branchial processes alone would not be sufficient to ally this form in any close connection with *Branchiodrilus*, since the genus *Dero* among the Naididæ also possesses similar organs, and there is no reason to suppose that such physiologically similar organs may not have arisen independently.

But when, in addition to the mere occurrence of branchial processes, we consider their distribution in the anterior part of the body, their gradual diminution in size posteriorly, their length and shape, and the fact that anteriorly they enclose the dorsal hair-setæ, while posteriorly these setæ project freely, we must

conclude that we have here a collection of morphological resemblances which are comparatively unimportant from a physiological standpoint, and which it is in the highest degree improbable should have arisen independently.

Admitting then the close connection of the two forms, is it possible to unite them in the same genus? Most of the differences between the two are obviously of only specific value; such are the greater extension posteriorly of the branchial processes in the present form; the absence of sickle-shaped setæ in the dorsal bundles, and of any difference between the anterior and posterior setæ in the ventral bundles; the colourless character of the cœlomic corpuscles; and, possibly, the pulsation of the anterior lateral vascular loops and the ciliation of the general body-surface, which two last characters do not appear to have been observed in *Branchiodrilus*.

The difference in the anterior limit of the dorsal setal bundles (and branchial processes) belongs, however, to a different category. Such a feature has generally been held to be of generic and not merely specific value. Thus the presence of dorsal setæ on all segments from the second onwards is mentioned as a feature in the generic diagnosis of *Branchiodrilus* in Bourne's original paper [2], in Beddard's Monograph of the Oligochæta [1], and by Michaelsen [5]; a similar feature is the chief, if not the only, generic distinction between *Naidium* and *Nais*; Beddard ([1], p. 281), merging together a number of genera of other authors under the one name *Nais*, does so largely because they "agree in the important fact that the first five segments are cephalized,—that the dorsal setæ do not commence until the sixth segment," and by implication would exclude from the genus any form which did not show this cephalization. Similarly *Pristina* and *Naidium* are united by him on the ground of the absence of this feature. Bourne [3] also believed that the number of cephalized segments is constant for the genus, and thought it probable that *Dero furcata*, possessing four achætous dorsal segments, should on this account be removed from the genus, since the other members of it have five such segments.[1]

It seems necessary, therefore, to erect for the present form a new genus, for which I suggest the name *Lahoria*, with *hortensis* as a specific distinction. I believe notwithstanding, on the ground of the similarity of distribution of the branchial processes and of their relations to the setæ in the two forms, that the connection between the present form and *Branchiodrilus* is a close one; and if this be admitted, it is perhaps worth while asking whether a cephalization which affects only the setal distribution (for the absence of gills on segments ii-v of the present form is evidently correlated with the absence of the setæ which are necessary to

[1] On the other hand Michaelsen [5] unites into one genus *Paranais* the *Naidium naidina* of Bretscher, *Paranais littoralis* of Czerniavsky, and *Uncinais* (*Ophidonais*) *uncinata* of Levinsen, though their dorsal setæ begin respectively on the second, fifth and sixth segments.

stiffen them) has the systematic value hitherto generally attributed to it.

The same question is suggested by the fact that the cephalization is itself a variable feature, sometimes more, sometimes fewer segments being so differentiated. Thus, while in most of the genera of the Naididæ which show this feature the dorsal setæ begin in segment vi, they begin in iii in *Amphichæta*, in v in *Bohemilla*. Again, the feature varies within the same genus; in *Dero* some species bear the first dorsal setæ on segment v, others on vi. Lastly, the feature varies in individual specimens of the same species; this has already been stated for the present form; it is asserted for *Nais communis* by Piguet [9]; and it possibly occurs in a *Slavina*, according to my observations [11], though these may possibly have been made on specimens which had separated before the complete production of their anterior segments in the budding zone, and in which possibly the full number would subsequently have been formed.

II.—On the Reproductive Organs of *Nais variabilis*, Piguet, var. *punjabensis*, and of *Chætogaster orientalis*, mihi.

The usual mode of reproduction in the Naididæ is the asexual, by fission. The sexual organs have not hitherto been much used in the discrimination of species, and are not referred to in specific diagnoses; they cannot be said to be well-known in more than a limited number of species, and in many have not even been seen. It is probable, nevertheless, that a fuller knowledge of the sexual organs of the Naididæ would be of considerable systematic value; with regard to the genus *Nais* for example, Michaelsen [6] says, "Die bedauerliche Unsicherheit, die noch immer in der Diagnoscirung der Arten des Genus *Nais* herrscht, mag meiner Ansicht nach am leichtesten durch eine exacte Klarstellung des bisher zur systematischen Gliederung dieser Gattung nicht in Rücksicht gezogenen Geschlechtsapparates gehoben werden." The following account of the sexual organs of two species, one of them belonging to the genus *Nais* referred to above by Michaelsen, may therefore be useful.

Nais variabilis, Piguet, var. *punjabensis* (plate viii, fig. 1).

In a former paper [11] I gave an account of certain features of the reproductive apparatus of this form, as far as they could be made out by microscopic examination of the living animal. Any such account must, however, be very incomplete, since after the formation of the clitellum none of the details are any longer visible; and, as a matter of fact, I had not then seen the male efferent apparatus, which is perhaps the most important part of the system for comparative purposes.

The present description is founded on sections prepared from specimens taken in the Shalimar Gardens, near Lahore, in March,

1909. The animals were present in one of the tanks in considerable numbers, along with *Chætogaster orientalis*; and a fair proportion of both species were in a condition of sexual maturity. For the sake of completeness I have incorporated in the present account a certain number of the facts recorded in my earlier paper.

Both sexual and asexual reproduction may go on together. The testes are the first organs to be formed, and appear on examination of the living worm as homogeneous hyaline masses attached to the posterior face of septum 4/5. The sperm-morulæ ripen in the vesicula seminalis, but may sometimes be seen in the body-cavity of the anterior part of the animal, as far forwards as the third or even the second segment; and I have previously noted that slight violence may cause spermatozoa to be discharged through a rupture of the body-wall at the tip of the prostomium.

The vesicula seminalis, or sperm-sac, forms early, and is properly (plate viii, fig. 1) an extension of septum 5/6; later it becomes much dilated, extending backwards through the sixth, seventh and eighth segments, and finally may even reach the tenth.

The relations of the funnel of the vas deferens will be understood after reference to fig. 1. The mouth is turned backwards into the sperm-sac; it is of fair size, and the lip of the funnel appears in some specimens to be much prolonged on one side (apparently not always the same side), so that the plane of the opening is very oblique. The tube is fairly broad, and is lined by cells of approximately cubical shape; it at first passes vertically down along the septum, then takes one or two bends, but is not coiled. It opens by a rather wider portion into the atrium, on the anterior face of the latter, a little below the middle of its height. Its more or less horizontal portion is surrounded by prostatic cells, in two or more layers. The atrium is approximately spherical, is lined by cells which are a little higher than broad, and has only a thin external muscular coat. The passage to the exterior is short, and opens into a shallow funnel-shaped depression of the surface; the passage and funnel-shaped depression are lined by columnar cells. On a surface view of the animal these depressions are distinguishable as clearer spaces in the opaque clitellum.

The ovaries form soon after the testes, and are attached to the posterior face of septum 5/6. The ovisac is a diverticulum of septum 6/7; its relations may be seen in fig. 1. The sperm-sac is included within it, and the ova lie as a rule behind the sperm-sac, sometimes as far back as segment x; they may however lie on one side of it, so that some sperm-morulæ or spermatozoa may occupy a position posterior to that of the ova. Eggs are seen in various stages of development; in their later stages they accumulate within themselves an enormous amount of yolk-matter; I did not in my former paper recognize how enormous (for so small an animal) this aggregation of yolk might be (*y*, fig. 1; a much larger mass is shown in fig. 21 of my previous paper); and I was led to describe it and the spherical glancing particles of which it is composed as

something apart from the ova. I have not seen any trace of female apertures in my specimens.

The spermathecæ are in the fifth segment, opening externally not far behind the level of septum 4/5. At first they are small, somewhat pear-shaped or sausage-shaped, extending vertically upwards. Later they become much elongated, and extend backwards into the seventh segment, being contained within the cavity of the sperm-sac. In this stage they are full of spermatozoa ; the wall of the receptacle is thin, and its cavity sharply marked off from that of the passage to the exterior, where the lumen is very narrow, and the wall thick (fig. 1).

The clitellum forms after the sperm-sac has developed, but before the spermathecæ and male ducts. When fully formed, it includes segments v, vi and vii, ending by a fairly definite margin both in front and behind. It consists of a single layer of cells, much larger and taller than those over the general surface of the body ; these cells in sections prepared in the usual way are seen to have their nuclei near their base, while the greater part of the remainder of the cell shows a large vacuole (fig. 1). On examining the surface of the clitellum in the living animal, it is seen to be tuberculated, and each tubercle appears to be compounded of a number of smaller ones : the large tubercles seem to correspond to individual cells, while each smaller tubercle corresponds to a circular refractile particle, of the same appearance as the glancing particles of yolk in the ripe ovum ; when the animal breaks up under examination, the disintegration of the clitellum gives rise to a number of circular masses, each compacted of a number of these particles ; these masses appear to be each a portion of an epithelial cell of the clitellum,—the superficial portion apparently, which in the prepared sections is represented by the vacuole and surrounding cell-substance. The appearance of the surface of the clitellum under an oil-immersion lens is represented in plate viii, fig. 2.

The genital setæ are described in the paper already referred to.

Chætogaster orientalis, mihi (plate viii, fig. 3).

When I first [10] gave a description of the present species of the genus *Chætogaster* under the specific name *pellucidus* (which I have since learnt was preoccupied), I had only had the opportunity of observing the sexual organs in a single specimen. I have now to give a more complete description, as well as to correct certain errors of interpretation in my former paper.

The specimens on the examination of which the present account is founded were obtained near Lahore in February and March, 1908. Other sexually ripe specimens have been obtained from Shalimar during the present month, March, 1909. The animals therefore, like the *Nais* previously described, have their period of sexual maturity in the early part of the year in this climate.

Both sexual and asexual reproduction may go on together. This is noted by Piguet [9] for *C. diastrophus*, which, according to

that author, buds at all times except when in an advanced condition of sexual development. In the present species however the limitation just expressed does not hold; all the specimens I have seen, whether sexually ripe or not, show one or more zones of budding; the single individual is never met with, but always a chain.

The testes seem to disappear early, and I could not distinguish them in a specimen which showed sperm-morulæ in all stages of development, but no other genital organs, male or female, except the ovaries in an early stage. A small granular mass situated near the ventral body-wall and a short distance in front of the funnel of the vas deferens, seen in a specimen (plate viii, fig. 4) which had developed the male efferent apparatus but not the clitellum, perhaps represented a testis, whose disappearance may have been somewhat delayed.

The funnel of the vas deferens is in segment v, on the anterior face of septum 5/6; it is ciliated. From it the vas deferens runs backwards in segment vi, with a somewhat curved course in living specimens, to the atrium; this is an oval or stoutly spindle-shaped dilatation of the tube, from which a short ejaculatory duct leads to the exterior. The male aperture is at the level of the setæ of segment vi, which are modified as described below (genital setæ). There is no prostate.

There is also no sperm-sac. Sperm-morulæ in all stages of development are scattered throughout the body-cavity of the animal; and not only through the body of the anterior animal which contains the reproductive organs, but through all the members of the chain. Spermatozoa may be seen passing from one segment to another through the incomplete septa, and may reach as far forwards as the pharyngeal region.

The ovaries are two cellular masses (described as testes in my former paper) in segment vi, at the level of or slightly anterior to the atrium on each side. They seem to appear early; one specimen showed two hyaline protoplasmic aggregates in which cell outlines were not (in the living condition) visible; these were suspended in the ventral part of the body-cavity on fine strands passing between the alimentary canal and body-wall, one on each side at a level a little in front of the setæ of segment vi; with the exception of sperm-morulæ, these, which were apparently an early stage of the ovaries, were the only signs of sexual organs.

There is no ovisac, and the ova ripen in the general body-cavity. Though ova are sometimes met with in the posterior animals of a chain, they are more usually found collected in the posterior part of segment vi, and here may cause a fairly definite backward bulging of the septum. The larger size of the egg-masses as compared with the sperm-morulæ probably occasions the restriction of their wanderings. What I figured in my earlier paper as an ovary is such a collection of ova.

The ripe eggs are of considerable size, and consist mainly, like those of the species of *Nais* previously described, of aggregations of glancing particles of yolk, opaque in mass by transmitted light.

The aggregate, when it has attained some size, is visible to the naked eye as a brilliant white spot.

A curious condition was found in a number of animals examined about the same time of the year as those containing well-marked sexual organs. Those to which I now refer had no clitellum, and no male organs or male products, but showed throughout their extent masses of what was apparently yolk-substance. In some cases these masses were large, filling up nearly the whole diameter of the body-cavity; in others they were numerous and small, somewhat resembling sometimes the white cœlomic corpuscles of the Punjab variety of *Nais variabilis* [11], but showing no nucleus on staining. In a few cases small isolated masses of ova were found along with these aggregations of yolk. These animals may have been individuals which had passed through their sexual stage and had failed to get rid of all their female products; or possibly they were the posterior animals of a chain, into which, contrary to the usual rule, female products had spread; the chain then breaking up, these products had been retained by the posterior animals without any means of getting rid of them. The eggs would, on this supposition, have entered the posterior components of the chain while still small, and would have formed their yolk there; eventually breaking up they might thus give rise to the appearances observed.

The spermathecæ are two short oval structures attached to the posterior face of the septum which delimits the short œsophagus from the distended crop. This is probably septum 4/5 (not 3/4, as I assumed in my earlier paper), and the organs are, as commonly in the Naididæ, in segment v. They open externally by a short passage; the pore has somewhat tumid lips. They develop rather late, and may be absent after the full development of the ovary and male efferent apparatus.

The clitellum is situated primarily on segment vi, and spreads later half-way over both v and vii, thus coming ultimately to occupy a space of about two segments. It is a tuberculated area, the tubercles being at first minute and discrete. Each tubercle appears singly as a small round clear particle; but the region as a whole is opaque, though not so densely opaque as in other Naididæ, *e.g.*, *Nais* and *Pristina*. The clitellum forms late, and may still be absent after the establishment of all the other organs. The order of development of the various organs is thus: testes, ovaries, male efferent apparatus, spermathecæ, clitellum.

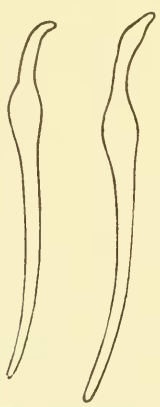

Fig. 4.—Two genital setæ of *Chætogaster orientalis*.

The genital setæ are the modified setæ of the sixth segment They make their appearance during the time of development of the male efferent apparatus; thus in a specimen in which the funnel was not yet ciliated, and

where the ejaculatory duct was not yet formed (the atrium appearing as a rounded mass sessile upon the inner side of the body-wall), there were, in addition to the normal setæ of the segment, small setæ with the characteristic distal ends of the genital setæ developing beside the normal setæ in the body-wall. The genital setæ (text-fig. 4) are shorter and stouter, as well as fewer in number (*e.g.*, three on each side) than the normal setæ of the segment. The nodulus is very large and prominent, and near the distal end; the distal end is blunt and not forked. These setæ vary somewhat in shape, as for example in the degree of bluntness of the end, and they may or may not present a slight swelling just proximal to the tip.

III.—On a Species of *Dero* found in Lahore; a contribution to the *Dero*-question.

A number of specimens of this form were discovered in the mud from a pond near the boarding house of the Government College, and were brought to my notice by Lala Bishambar Das, my demonstrator, in November, 1908. The pond has since been drained, and the form has not been met with again.

External characters.—The animals were thin and filiform when extended, in length from 10 to 12 mm. Most of the animals were preparing to divide, and showed a zone of newly budded segments about the middle of their length. The number of distinguishable segments in each half of such an animal was about twenty. There were no eyes. The prostomium was bluntly conical, and the posterior end of the body was slightly swollen in a club-shaped manner. The animals moved backwards quite easily.

Gill-processes.—The anus opened posteriorly at the bottom of a funnel-shaped depression, the base of the funnel facing dorsalwards. Ventral and posterior to the funnel, the posterior end of the body was prolonged into a pair of finger-shaped lobes, which could be curved dorsalwards and thus bent over the gill-processes about to be described, but were not completely retractile, though they could be appreciably shortened. These processes were not ciliated, and did not contain blood-vessels: they bore a number of sensory "hairs."

On each side of the funnel, extending in a line forwards and dorsalwards from the posterior tactile processes just described, were four vascular gill-processes. These diminished in size from behind forwards, the most anterior being thus the smallest. All were rounded, tuberculated, ciliated, and vascular; they were very contractile, and hence their appearance varied much from time to time. The smallest, most anterior gill on each side was a projection of the margin of the funnel; the other three appeared to be inserted just within the margin in such a way that when fully expanded the margin of the funnel disappeared as a continuous line, but when contracted the margin of the funnel appeared as a

separate and distinct line enclosing the bases of the gill-processes. A number of variations, in different animals and at different

Fig. 5.

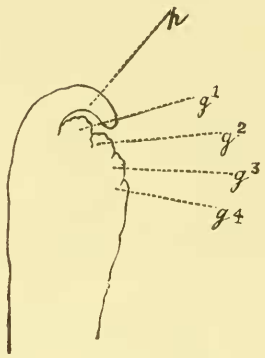

Fig. 6.

Figs. 5, 6.—Posterior end of body of *Dero* sp.: *p.*=palp; g^1.—g^4.=gill-processes. Fig. 5 shows a much contracted condition, the gills not projecting from the funnel at all.

times, are shown in the figures (plate vii, figs. 4—6, and text-figs. 5 and 6).

Fig. 7.—Dorsal needle-seta of *Dero* sp., showing relative sizes of prongs of fork, and a second slight irregularity of outline distal to nodulus.

Setæ.—The dorsal setal bundles began on the fifth segment; each bundle consisted of one hair- and one needle-seta. The hairs were fine, smooth, pointed, and about ·16 mm. long, or nearly as long as the body of the animal was broad. The needles had a slight double curve (text-fig. 7), and were forked distally, the prong on the outer side of the curve being slightly shorter and much thinner than that on the inner side; the nodulus was situated at the junction of the distal and middle thirds, and there was a second slight nodulus, or rather perhaps an irregularity of contour merely, a little way distal to the first. In length these needles were about ·05 mm.

The ventral setæ (text-fig. 8) were of the usual double-curved and forked type, usually four, occasionally two or three in a bundle; the bundles began in the second segment. Two types were distinguishable; those of the second, third, and fourth segments had the prongs of the fork of the same thickness at their base, and the distal prong half as long again as the proximal; in the remaining segments the prongs were almost equal in length (the proximal being possibly very slightly the longer), and the proximal was twice as thick as the distal at its base. The length of the setæ varied from ·06 to ·05 mm., those of the anterior segments being slightly longer than those of the posterior; the thickness was about the same. 2·2 μ throughout.

Fig. 8.—Ventral seta from a posterior segment of *Dero* sp.

The position of the nodulus was found to vary regularly in each bundle. This may be illustrated by the following tables:—

(*a*) Setal bundle of iv segment—

Total length.	Prox. to nodulus.	Distal to nodulus.
·058	·026	·032
·058	·029	·029
·062	·032	·030
·054	·032	·021

(*b*) Setal bundle of a posterior segment—

Total length.	Prox. to nodulus.	Distal to nodulus.
·056	·026	·029
·056	·029	·026
·057	·035	·022
·053	·035	·018

The series in each case begins from the innermost seta of the bundle. It will be seen that in each bundle the inner seta has the nodulus proximal to the middle of its length, while in the outer seta the nodulus is markedly distal; and that the intermediate setæ show intermediate conditions.

Lymph corpuscles may be present or absent, and when present they were of two kinds. Both were spherical; but one variety contained a number of shining white granules, while the other contained a small number of fairly large yellow refractile spheres, looking like small oil droplets. These two kinds of corpuscles were similar to those described for the Punjab variety of *Nais variabilis* [11] (plate viii, fig. 6).

Alimentary canal.—The pharynx occupied segments ii, iii and iv, and the œsophagus v and vi. Around the œsophagus, in segments v and vi, were lobular hyaline masses somewhat resembling the "septal glands" of *Pristina*. There was no distinct stomach;

chloragogen cells covered the alimentary canal as far forwards as septum 6/7 (plate viii, fig. 5).

Circulatory system.—The dorsal vessel was attached to the alimentary wall as far as septum 6/7, where it became free. The ventral vessel was non-contractile, was quite separate from the intestine except posteriorly, and gave off segmental branches to the intestine, which entered a ventral intestinal sinus, or median vascular channel in the intestinal wall. Posteriorly, at a little distance in front of the hinder end of the body, the ventral vessel became joined to the wall of the intestine; finally it bifurcated, the two branches curving round dorsalwards and then gently bending inwards to unite and form the posterior end of the dorsal vessel. Before meeting, they branched once or twice; the branches, however, soon re-united (plate viii, fig. 7).

There were, as a rule, five lateral commissural vessels connecting the dorsal and ventral vessels in the anterior part of the body; of these, the first was in segment vi, the last in x; the largest was that in vii, the next largest that in vi, then those in viii, ix, and x in the order given. Several variations, however, were observed; in one case the first lateral vessel was in segment vii; in another case, in addition to the five usual vessels, there was also a small vessel in v; in another case there were four only, in segments vi-ix. All these vessels were contractile.

The blood is red.

Nephridia.—The first nephridium occurred in the seventh segment; but here again there were variations. Thus in one case the first nephridium was in segment viii; in another, the first was in vii as usual, but the eighth segment had no nephridia.

It will be apparent, on looking over a list of species of the genus *Dero*, that the presence of palps at the hinder end of the body excludes the present form from all species, except *vaga*, *stuhlmanni*, *furcata*, *tonkinensis*, *schmardai* [7] and *palustris* ([8], *Aulophorus palustris*). The form of the dorsal setæ excludes it from *D. stuhlmanni*, *vaga* and *tonkinensis*; in *D. schmardai* the dorsal setæ begin in segment vi, the ventral setæ are far more numerous in segments ii-v, and the gill-processes are fewer; *D. palustris* has many more segments (50), and a larger number of gills (4 or ? 5 pairs), but this last form still awaits complete description.

The form to which the animal now described approaches most closely is *D. furcata*, Ok. The differences appear to be the following: the palps are much longer in *D. furcata*, appearing in Bousfield's figures ([4], figs. 17 and 18) to be, relatively to the diameter of the animal about three times as long as in the species here described; the gills also are longer, slenderer and almost cylindrical, in three pairs, of which one pair are "secondary branchiæ," *i.e.*, projections of the margin of the funnel only. Further, the present form differs in a number of characters from all the other species of the genus, according to the diagnostic summary given by Michaelsen [5]. Thus, according to his definition of the genus—

(*a*) the ventral setæ are throughout the genus longer in segments ii-v than in the rest of the body;
(*b*) the alimentary tube is dilated to form a stomach;
(*c*) the nephridia begin in the sixth segment;

to which may be added—

(*d*) the genus does not possess cœlomic corpuscles (Bousfield [4]); but it seems nevertheless (Beddard [1]) that these are present in *D. vaga*, from which, however, the present form is far removed.

With regard to the length of the ventral setæ, I have previously stated that in the present forms, those of the anterior segments are slightly longer than those of the posterior; but even this difference is gradual, not abrupt after the fifth segment; nor in any case is its magnitude such that it could be used as a diagnostic character (*cf.* figures for length of various setæ, p. 73, *ant.*).

As regards a stomachal dilatation of the alimentary tube, this is stated [7] to be not well marked in *D. schmardai*.

I have not seen any account of a species of *Dero* in which, as in the present form, the nephridia begin in the seventh segment.

Lastly, the character mentioned under (*d*) above is not an absolute distinction between the other species of the genus and the present one; since, as mentioned, cœlomic corpuscles are present in *D. vaga*, and may be absent in the present form.

A list of six or seven characters which distinguish this form from its nearest neighbour, especially when four of these are peculiar, or almost peculiar, to the present form alone, might perhaps be held as a sufficient warrant for the erection of a new species.

The species of the genus *Dero* are, however, variable in a high degree: this is illustrated in the present form by the variations recorded in the branchiæ, vascular commissures, cœlomic corpuscles and nephridia. Michaelsen, discussing this variability [6], alludes to the possible advisability of uniting all (European) species under two heads, *digitata*, without palps, and *furcata*, with palps. In such a case the present form would be included in *D. furcata*, which is, as we have seen, at any rate its nearest ally.

On reading Bousfield's paper already referred to, which I was only able to do after my examination of the worms had been completed, I was a little disconcerted as to the value of my observations by finding that, according to that author, "It is almost impossible to determine the species of any given example when ordinary methods, such as the compressorium or the live-trough, are alone employed;" the reason given being that, in the case of the compressorium, the full expansion of the branchial area, which is absolutely necessary for exact observation, is prevented. I do not however now think that a thin cover-glass would so greatly reduce the length of palps and gills as to explain the great difference between his figures and mine, and I observe that Michaelsen [6], [7], [8] has lately described new species from preserved material.

Since, however, my acquaintance with the genus is limited to

the present form, I will not definitely pronounce an opinion as to whether the range of variability in the genus is such, and the characters of the form now described are so distinctive, as to render the erection of another species desirable. The above account may however be of use as a contribution to the "*Dero*-frage," concerning which Michaelsen writes [6]: "Trotz Bousfield halte ich eine Revision der Gattung *Dero*, zumal eine ausführlichere, auch die Borstenverhältnisse berücksichtigende Beschreibung der verschiedenen Formen oder Arten, noch für ein Desideratum."

As recommended by Michaelsen, I have paid particular attention to the setæ; whether the peculiar relations shown by the position of the nodulus in the several component setæ of a ventral bundle will also be found, when looked for, in other members of the genus, cannot be predicted; it has not been noticed by the last-mentioned author in his recent detailed description of *D. schmardai* [7] and *D. incisa* [6], and it may not improbably be found to be of systematic value.

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